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TEST AND EVALUATION OF DUI ECONO II HOT WATER HEATER,(U)
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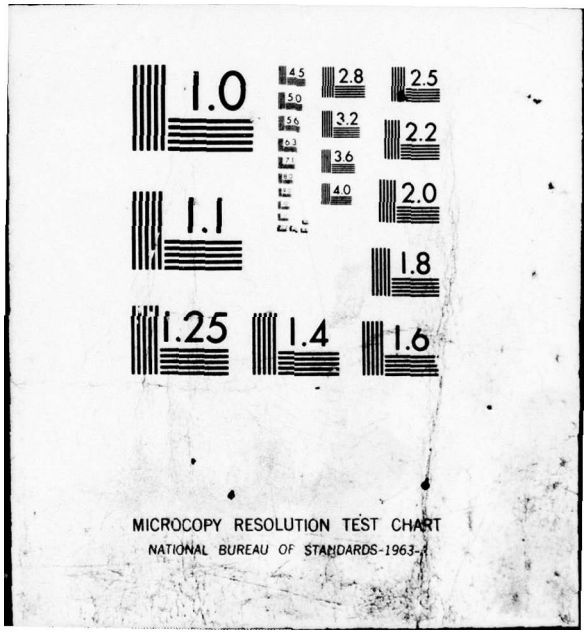
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DEPARTMENT OF THE NAVY
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PANAMA CITY, FLORIDA 32407

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TEST AND EVALUATION OF DUI ECONO II HOT WATER HEATER

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APRIL 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

D.U.I. Econo II Hot Water Heater was tested and evaluated by the Navy Experimental Diving Unit.

The unit is recommended for addition to the list of equipment Authorized for Navy Use (ANU), NAVSEA Instruction 9597.1

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ABSTRACT

The Diving Unlimited International (DUI) ECONO II Hot Water Heater was evaluated by the Navy Experimental Diving Unit to determine its suitability for Navy use. Results of both the manned and unmanned testing showed that the ECONO II Hot Water Heater would adequately support two divers in depths less than 100 fsw. Operationally, the unit proved to be reliable and portable. The Diving Unlimited International (DUI) ECONO II Hot Water Heater is therefore recommended for placement on the list of equipment Approved for Navy Use (ANU), Enclosure (2) to NAVSEA Instruction 9597.1.

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LIST OF ABBREVIATIONS

fsw.....feet sea water

gpm.....gallons per minute

psi.....pounds per square inch

1.0 INTRODUCTION

1.1 Objectives

Over the full test period the Diving Unlimited International (DUI) ECONO II Hot Water Heater was evaluated for the following characteristics.

a. Hot Water Flow
b. Temperature Control
c. Ease of Operation
d. Maintenance Requirements
e. Portability
f. Reliability
g. Safety

1.2 Scope

The Navy Experimental Diving Unit was tasked in March 1977 by Naval Sea Systems Command to perform an evaluation of the ECONO II Hot Water Heater for the purpose of including this heater on the list of equipment Authorized for Navy Use (ANU).

1.3 Background

In May 1977 the ECONO II Hot Water Heater, see Figure 1, was subjected to unmanned testing at the Experimental Diving Unit in Panama City, Florida. The purpose of the testing was to determine if the system met manufacturers specifications prior to manned testing. Analysis of the data collected during these tests confirmed DUI manufactures specifications. The system was then shipped to the Naval Surface Weapons Center, Solomons, Maryland for manned testing during normal diving operations; and it was also used in the recovery of an F-105 and an F-14 Air Force Aircraft from Chesapeake Bay, Virginia, see Figure 2.

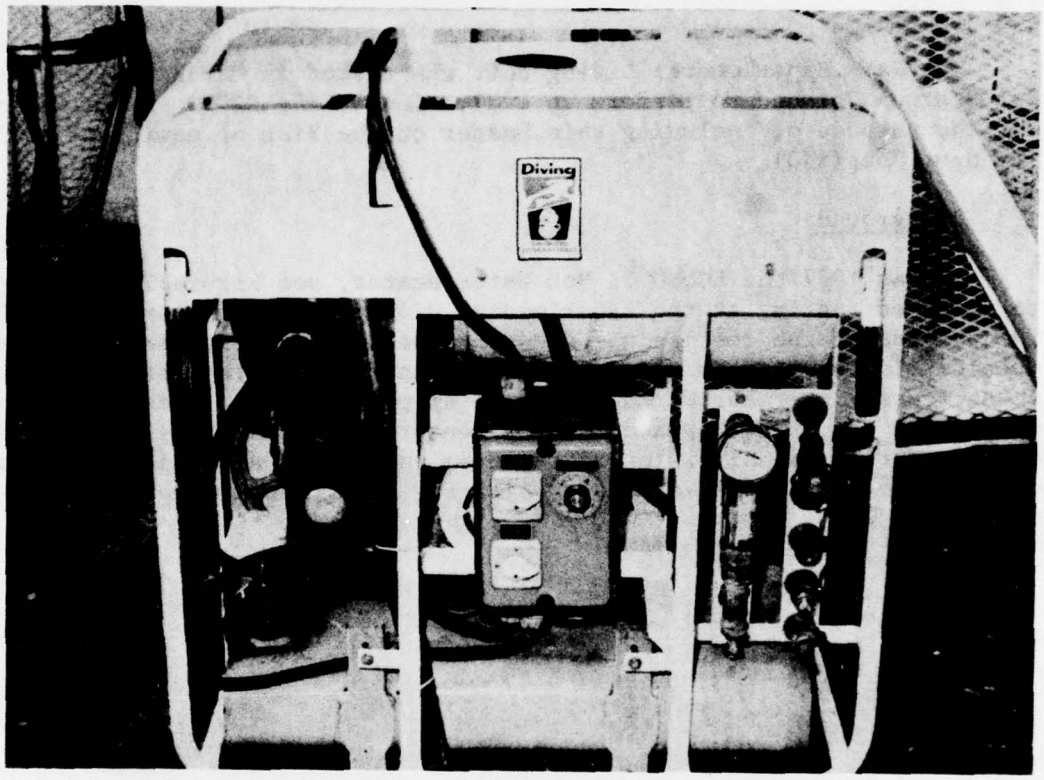

Figure 1 - DUI ECONO II Hot Water Heater

Figure 2 - ECONO II During F-105 and F-14 Recovery

2.0 DESCRIPTION

2.1 General Description

The DUI ECONO II Hot Water Heater is a compact, light weight water heater designed for maximum portability and minimum power requirements. The system is designed to supply two divers at depths to 100 feet sea water with 3 to 5 gallons per minute hot water at 70°F above inlet water temperature. Heater characteristics are given Table 1.

TABLE I

DUI ECONO II HOT WATER HEATER CHARACTERISTICS

Model: ECONO II Heater
Dimensions: Height 38", Width 21", Length 36"
Weight: 300 lbs.
Fuel Capacity: 10 gallons
Electric Requirements: 115 volts, 60 cycle A.C. single phase power, 20 amps
Fuel: #2 Diesel Oil
Pump Suction Head: 10 feet
The heater pump will deliver 4 to 5 gpm at 100 fsw.
Relief Valve: 125 psi

NOTES:

1. The heater will deliver 180,000 BTU/HOUR with a 2°-4° temperature variation.
2. This heater is not required to carry an ASME code because of its low working pressure and temperature, as outlined in ASME BOILER CODE, Section I, Paragraph 2.3.

2.2 System Components

The ECONO II Hot Water Heater contains 3 main assemblies, with subsystems as follows:

2.2.1 Electrical

a. 1 H.P. single phase, 60Hz, 115-220V motor for the pump
b. 1/3 H.P. single phase, 50-60Hz, 115-220V AC motor for the burner
c. An Ignition Transformer (on burner)
d. Electronic Temperature Controllers
e. Switches

2.2.2 Mechanical and Water Flow

a. Diaphram Pump
b. Blower Assembly
c. Flow Meter/Valves for Water Flow Control

2.2.3 Burner and Fuel

a. 10 gallon Fuel (#2 diesel oil) Tank
b. 10 Micron Fuel Filter
c. Fuel Pump
d. Soleniod Valve

2.2.3 Burner and Fuel (continued)

e. Pressure Gauge and Regulator
f. Ignition System
g. Fuel Nozzle
h. Miscellaneous - Tubes, Hoses, and Fittings

2.3 Functional Description

When the unit is connected to a power source, energy is supplied to the pump motor switch. When the pump switch is turned on, power is supplied to the burner motor switch; then the burner switch is turned on, the ignition transformer and blower are activated and power is supplied to the temperature controllers. The unit is now ready to fire and can be started by turning the control dial to a higher temperature setting. The unit will automatically fire and control temperature, see Figure 3.

Through a sensor probe placed in plumbing on the output side of the heat exchanger, the control unit senses the temperature of the water. When the water temperature is below the pre-set point (as chosen and set with the dial by the operator) the control unit will complete the electronic circuits going to both fuel valves, causing them to pass diesel fuel at 180 psi, causing a hi-fire condition. Once the temperature of the water has risen to the pre-set point, the control unit will open the electric circuit going to one fuel valve, thus closing the valve and forcing the fuel through a pressure regulator and reducing the fuel pressure to 100 psi. The burner is not in a Lo-fire state and will strive to maintain the water temperature at the pre-set point. When the water temperature falls below the pre-set point, the control unit will again cause the Hi-fire condition to exist, thus raising the water temperature and completing the Hi-Lo fire Sequence.

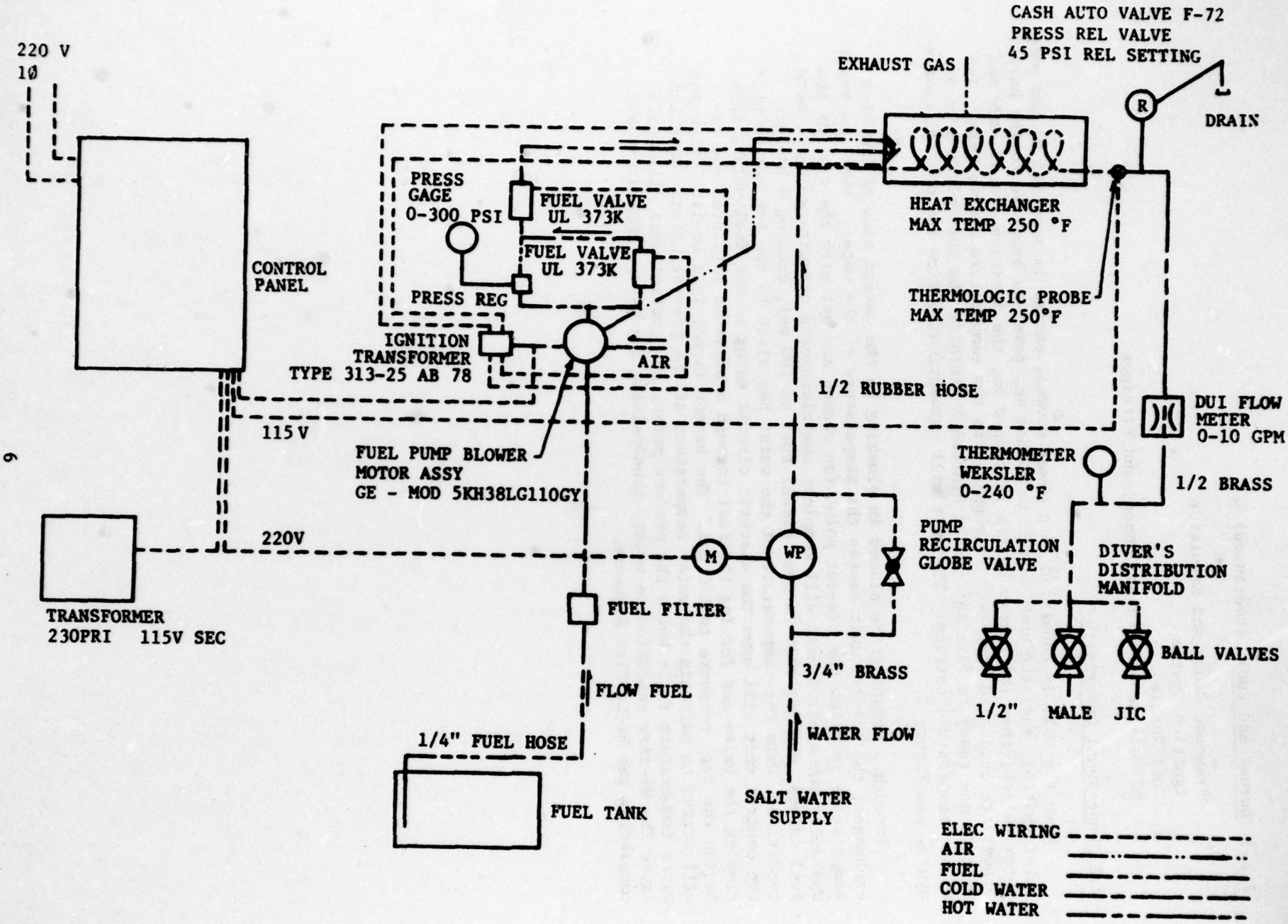

Figure 3. Econo II System Schematic

3.0 TEST PROCEDURE

3.1 Preliminary Arrangements

Unmanned testing was conducted at the Experimental Diving Unit in Panama City, Florida. The test setup is shown in Figure 4. The test equipment was installed as follows:

a. Thermisters at inlet and outlet of heat exchanger to measure water temperature in and out.
b. Flowmeter at discharge to measure water flow.
c. Validyne transducer across heat exchanger (Transducer to be later replaced by Capsahelic ΔP Gauge) to meausre differential pressure.

Unmanned testing proved satisfactory.

3.2 Manned Testing

In the first series of manned tests by Diving Locker Personnel from the Naval Surface Weapons Center, Solomons, Maryland, the ECONO II Hot Water Heater was tested for 15 hours. These initial tests were conducted in 50 feet of sea water and each dive averaged one hour and 45 minutes. The ECONO II system measured an outlet pressure of 70 psi and an inlet pressure 22 psi. Ambient water temperature averaged 40°F. The average hot water flow was 3 gallons per minute with an Aquastat setting 110°F. The outlet temperature was measured from 110°F - 115°F.

During salvage operations of opportunity involving the recovery of an F-105 and an F-14 in Chesapeake, Virginia, the Diving Locker Personnel logged an additional 80 hours on the ECONO II system. A total of 46 dives were conducted with an average dive time of one hour and 45 minutes. Ambient water temperature averaged 39°F. The heater outlet pressure was 65 psi with an inlet pressure of 20 psi. The hot water flow averaged 3 1/2 gallons per minute when two divers were being supplied. The equipment was set at 110°F, and the outlet temperature ranged from 107° to 113°F.

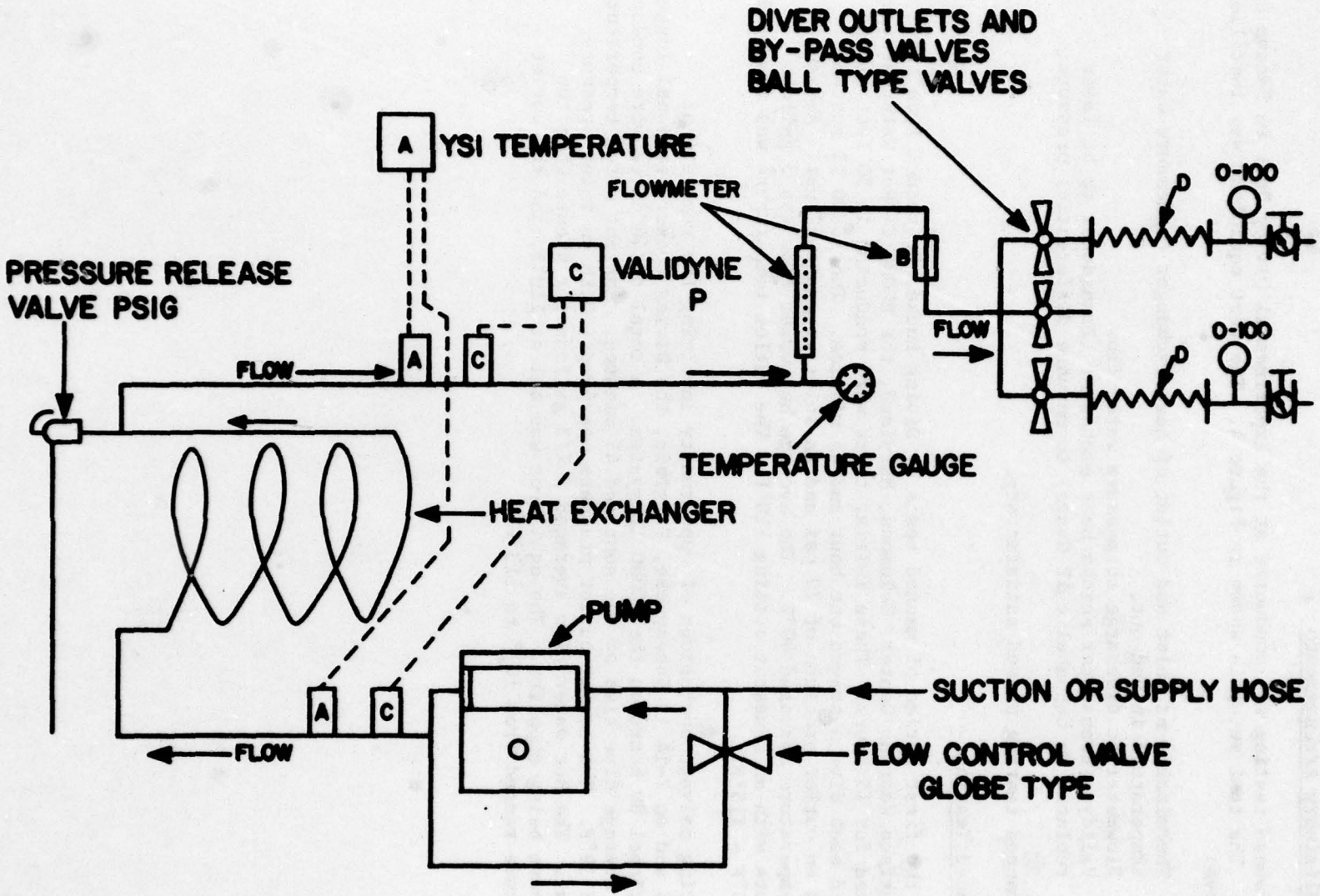

Figure 4. DUI Hot Water Heater Test and Evaluation Instrumentation

4.0 RESULTS

4.1 Test Results

Overall results of testing of the ECONO II Hot Water Heater were excellant and the unit performed in accordance with the manufacturers specifications. However testing revealed the following discrepancies:

a. The fuel pump lost prime if not used for 8 to 10 hours. The pump could be made operational by venting the system on start up.
b. The water suction hose lost prime if not used for a period of 8 to 10 hours. This was corrected by venting the water pump on start up.
c. The heater was not equipped with exhaust stack insulation to prevent personnel from burns or with a weather cover to prevent moisture from entering the heater.
d. Temperature gauges were difficult for the operators to observe from a standing position.
e. The carrying handles were installed to high for comfortable handling of the heater.
f. There was no gauge on the fuel tank.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 The DUI ECONO II Hot Water Heater is adequate to supply two divers to depths of less than 100 fsw.

5.1.2 Because of the minor discrepancies listed in Seciton 4.1, personnel utilizing this hot water heater must be made aware of same and make adjustments accordingly.

5.2 Recommendations

It is recommended that the DUI ECONO II Hot Water Heater be placed on the list of equipment Approved for Navy Use (ANU), enclosure (2) to NAVSEAINST 9597.1 series.

APPENDIX A

NAVSEA Assignment

INTER-OFFICE MEMO

TO CO, NAVXDIVINGU

DATE 28 JAN 1977

FROM NAVSEA 00C-DA

SUBJECT T.A. 29-77

MESSAGE Test and evaluate the contractor furnished. D.U.I Encono Heater in accordance with your test procedures. Compatability and concurrent testing with Task No. 26-77 appears appropriate. Point of contact for liaison on this task is LT MacDougal 00C-DB. A copy of your completed test report should be provided to D.U.I.; within your test report provide a recommendation as to the suitability for inclusion on NAVSEAISNT 9597.1

W. R. BERGMAN
By direction

REPLY

DATE 28 March 1977

DUI was requested by NEDU ltr ser 125 of 11 March 1977 to provide a heater direct to NEDU. Upon receipt, the heater will be inspected and then tested to determine if it meets its own advertised specs. A test plan now in preparation will then be used to determine the adequacy of the heater to meet Navy needs. The hot water hose obtained under Task #26-77 will be used in conjunction with this test. The full test program should complete in September 1977. A report will be provided to both NAVSEA(00C) and DUI upon completion. Information on the heater's performance under the cognizance of HCU-2 during aircraft recovery operations will be solicited and included in the NEDU report. NEDU point of contact is BMCS MANTELL.

R. P. DEMCHIK
LCDR USN

APPENDIX B

Test Plan and Test Equipment

1. Introduction. The aim of this test is to evaluate the Diving Unlimited International ECONO II Hot Water Heater for consideration for inclusion in NAVSEAINST 9597.1, list of diving equipments which are service approved or authorized for Navy use. The heater will be tested for:

a. Hot water flow

b. Temperature control

c. Ease of operation

d. Maintenance requirements

e. Portability

f. Equipment reliability

g. Diver safety

The heater will be subjected to unmanned testing at NEDU Panama City, Florida and to manned testing in actual diving operations at NSWC, Solomons, Maryland.

Naval Sea Systems Command (00C) has directed NEDU to evaluate the heater because the fleet needs a reliable, highly portable hot water heater to support dives made in frigid waters at depths less than 100'.

2. References.

a. NAVSEA TASK 29-77

b. NAVSEA TASK 26-77

c. NEDU Letter, Serial 126 dtd 11 Mar 1977

d. NAVSEA Letter, Serial 409 dtd 30 Mar 1977

e. D.U.I. Instruction Book

3. Test Number. 77-16

4. Priority. N/A

5. Program.

a. Inspect heater for damage upon receipt (20 Apr 1977)

b. Conduct unmanned tests at NEDU, Panama City, Florida (21 Apr - 6 May)

c. Transport heater to NSWC, Solomons, Maryland (May 1977)

d. Conduct manned testing for 3 months (May-July). Testing to be performed at convenience of Diving Officer, NSWC.

e. Transport heater to NEDU (Aug)

f. Report Issued Fall 1977

6. Preliminary Arrangements.

a. Assemble test equipment:

(1) YSI Temperature Indicator Model 44TA

(2) Two Thermisters

(3) Validyne P Transducer Model DP15

(4) Validyne Indicator Model CD12

(5) Capsahelic P Gauge

(6) Flowmeter

(7) Two 0-100 psi gauges

(8) Two valves

b. Assemble diving equipment:

(1) Two Bandmasks, MK-1 Mod 0

(2) Two 250' Umbilicals

(3) Two Hot Water Suits (MED, LG)

(4) One 1/2" I.D. Hot Water Hose (D.U.I.)

(5) One 3/8" I.D. Hot Water Hose (D.U.I.)

c. Arrange transportation to and from NSWC, Solomons, Maryland.

7. Test Procedure.

a. Install thermisters at inlet and outlet of heat exchanger to measure water temperature in and out.

b. Install flowmeter at discharge to measure water flow.

c. Install Validyne transducer across heat exchanger (Transducer to be later replaced by Capsahelic P Gauge) to measure differential pressure.

d. Upon completion of installation of test equipment, the heater will be taken to Alligator Bayou and operated for 6 hours daily for two days. A gauge (0-100 psi) and valve will be used with each umbilical to provide a back pressure equivalent to 100 FSW.

e. Readings will be taken hourly and logged.

f. Upon completion of unmanned testing at NEDU, the heater, umbilicals, and related diving and test equipment, will be crated and transported to NSWC, Solomons, Maryland to arrive by 4 May 1977.